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(54) **BUILDING STRUCTURAL ELEMENT**

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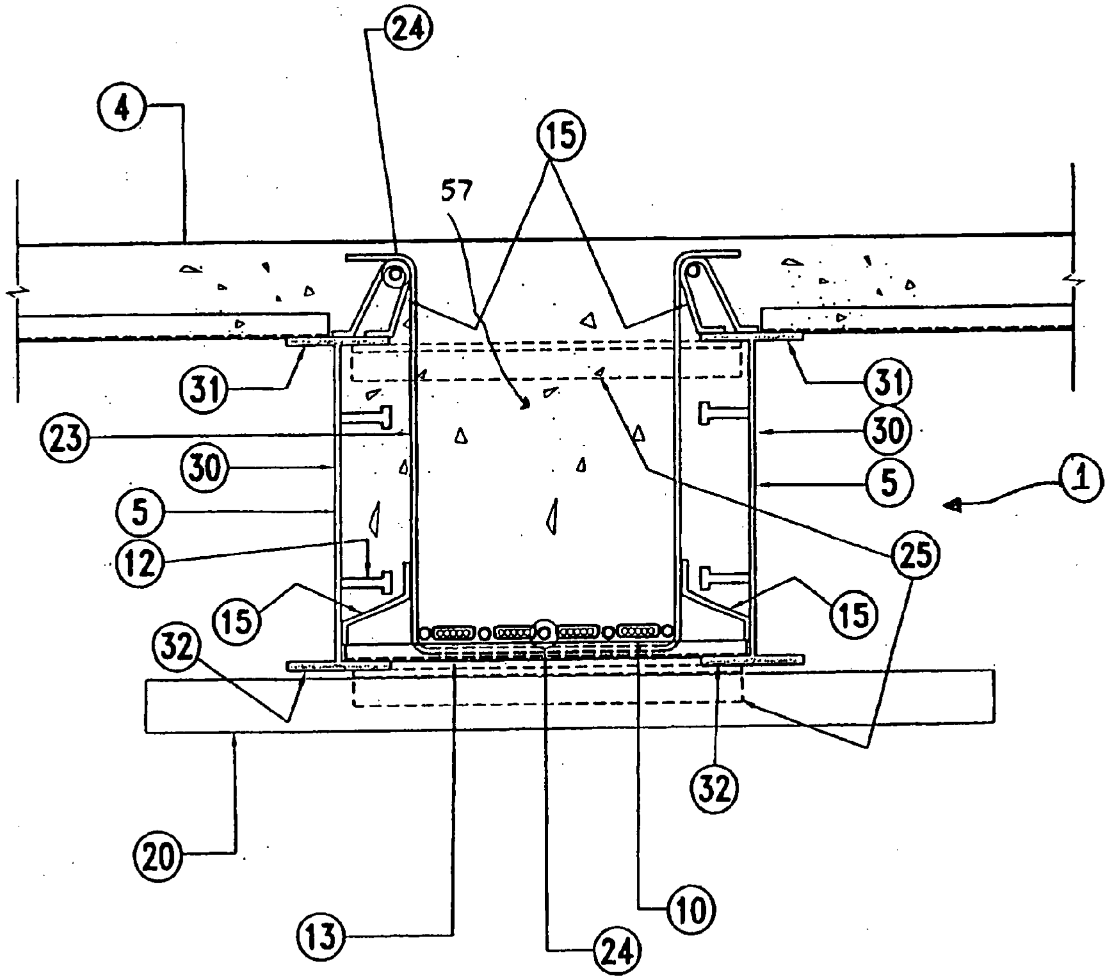
(57) **ABSTRACT**

A building structural element **(1)** having a pair of beams **(5)**joined by a plate member **(13)** or alternatively a generally U-shaped channel having a pair of opposed side walls **(33, 34)** joined by a further portion **(35)**. In either case an interior space **(57)** is defined by either the pair of beams **(5)** and plate member **(13)** or by the pair of side walls **(33, 34)** and the further portion **(35)**. A cementitious material, such as concrete, occupies a substantial volume of the interior space **(57)** and the building structural element **(1)** has a post-tensioned pre-stressing force applied thereto.



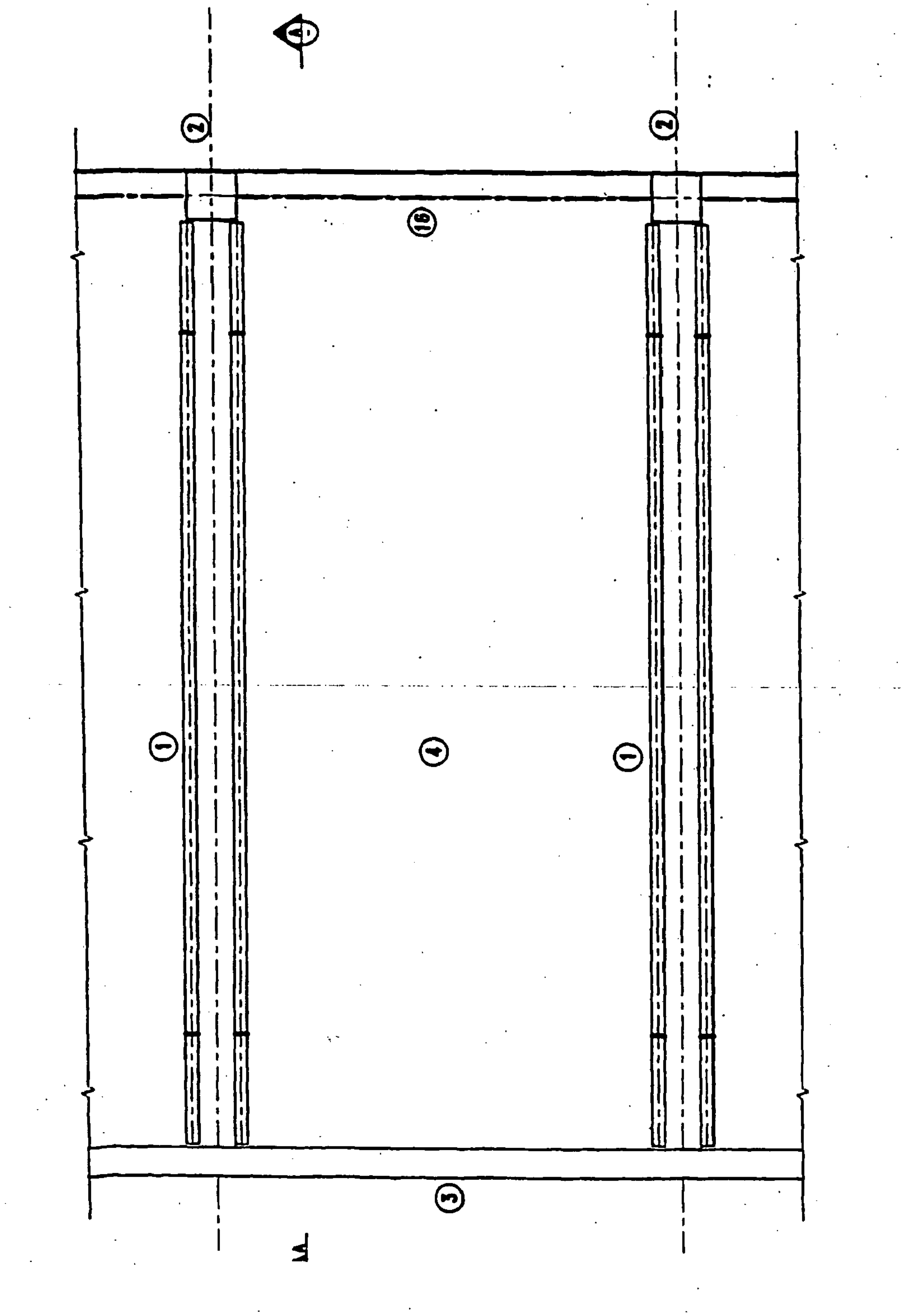


FIGURE 1

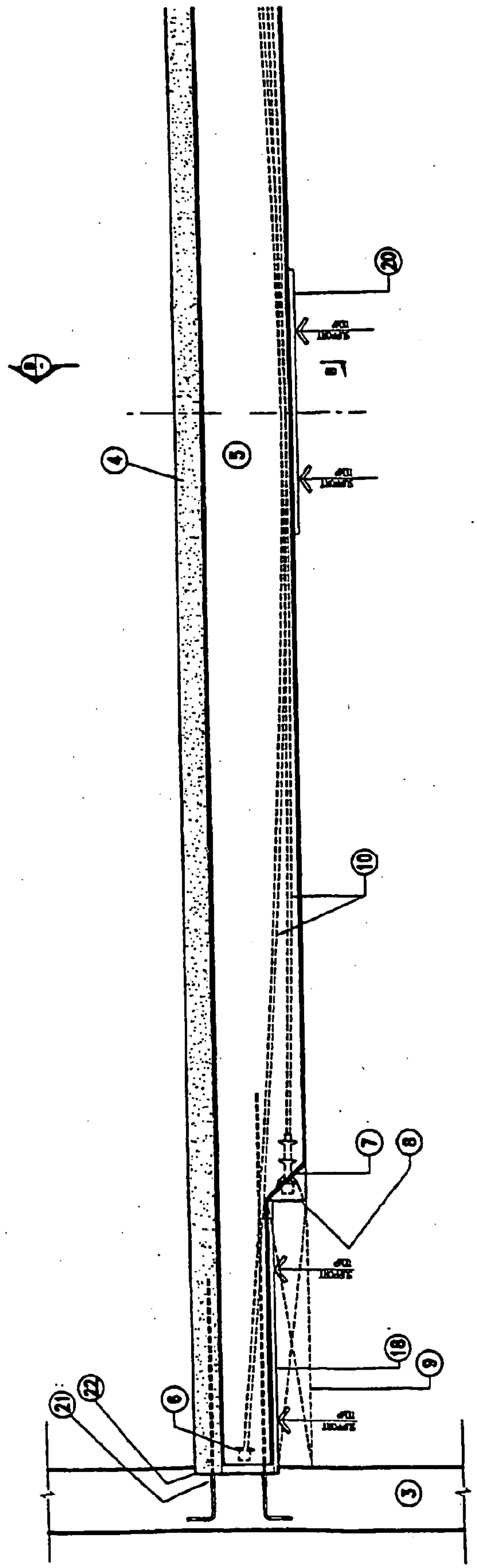


FIGURE 2(A)

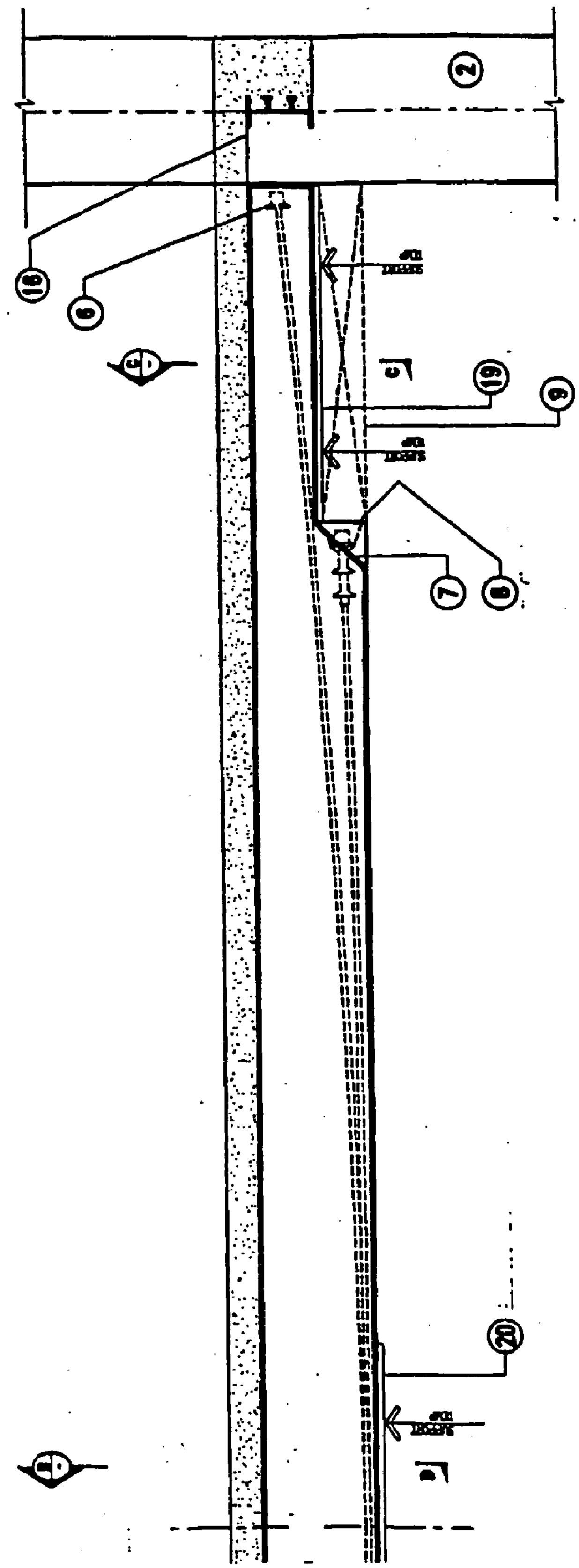


FIGURE 2(B)

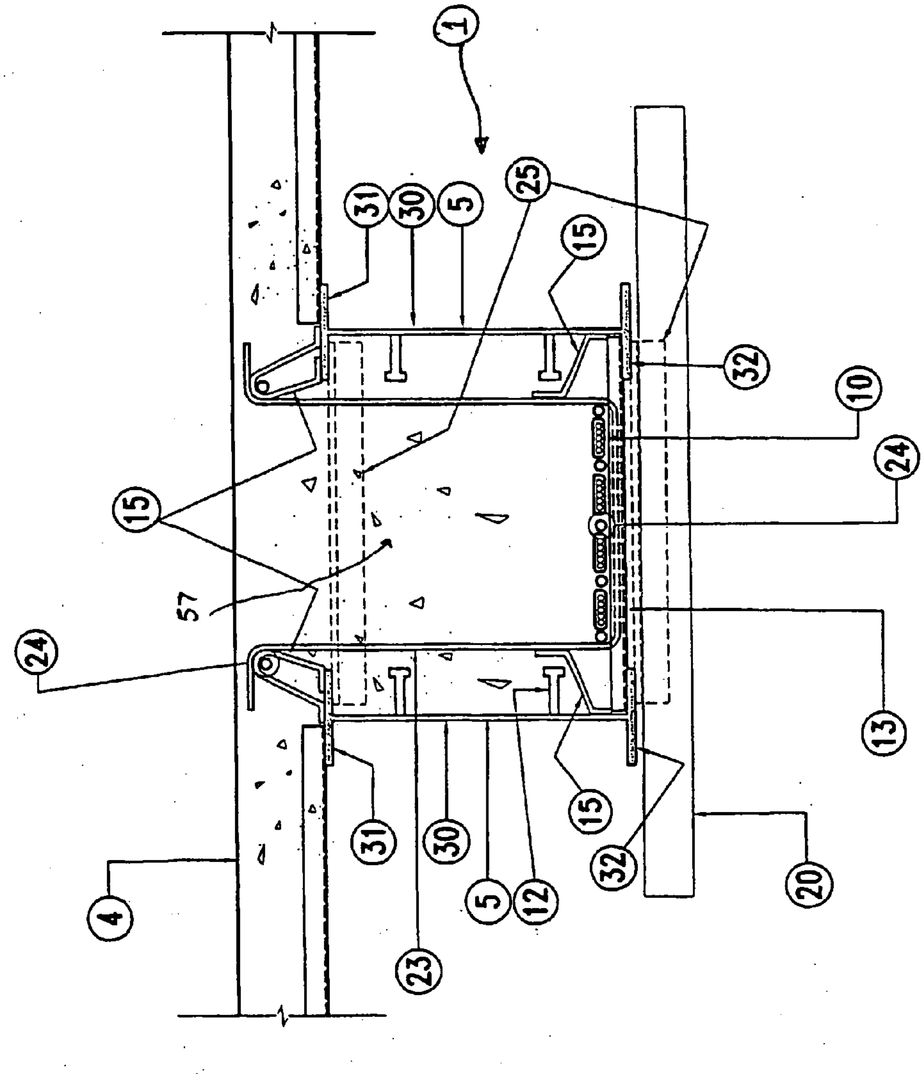


FIGURE 3

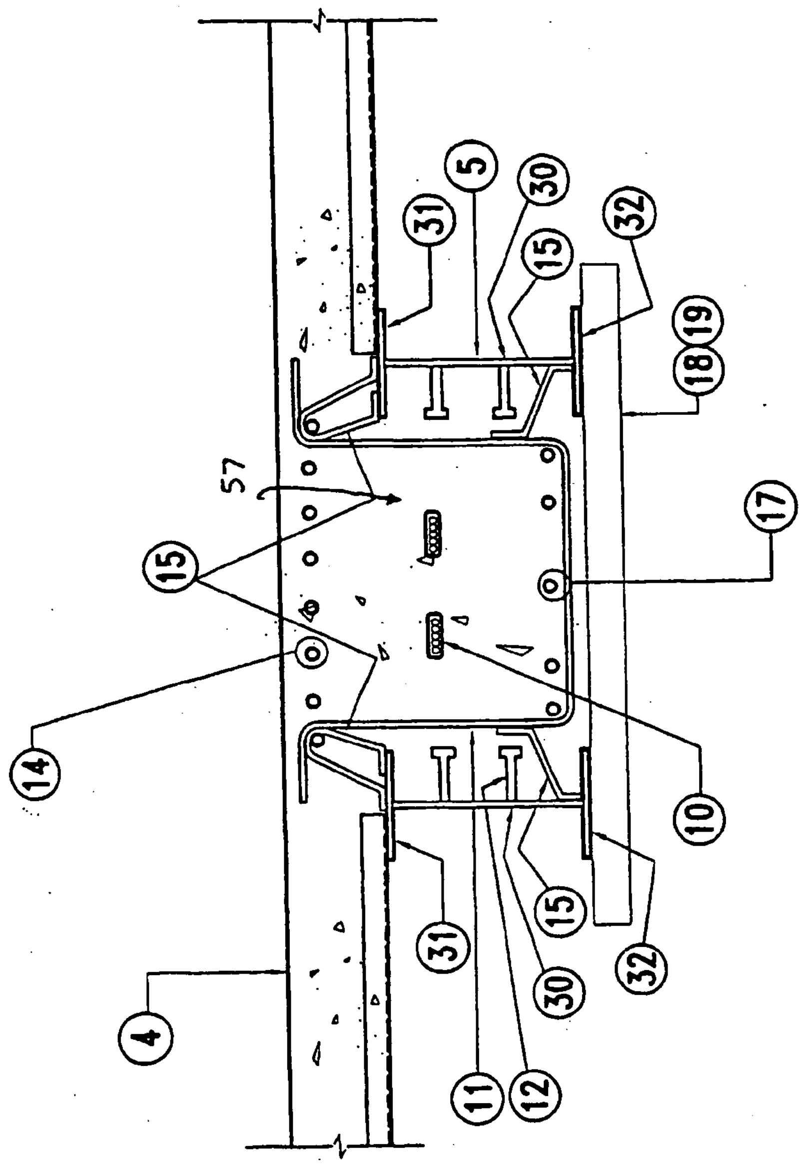


FIGURE 4

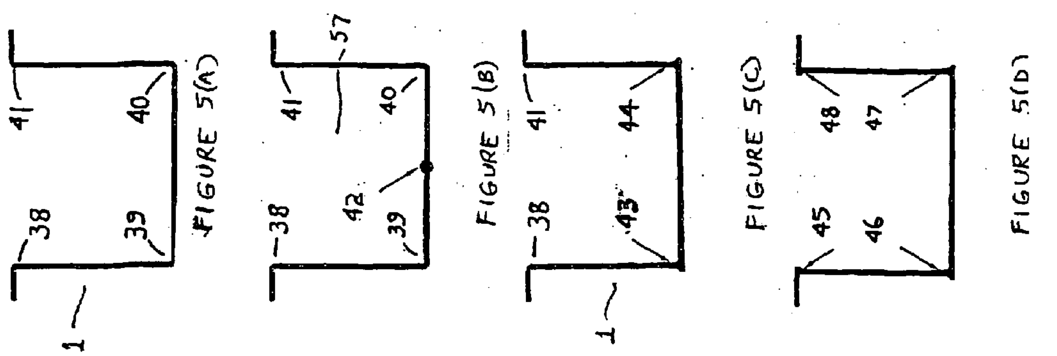


FIGURE 5(A)
FIGURE 5(B)
FIGURE 5(C)
FIGURE 5(D)

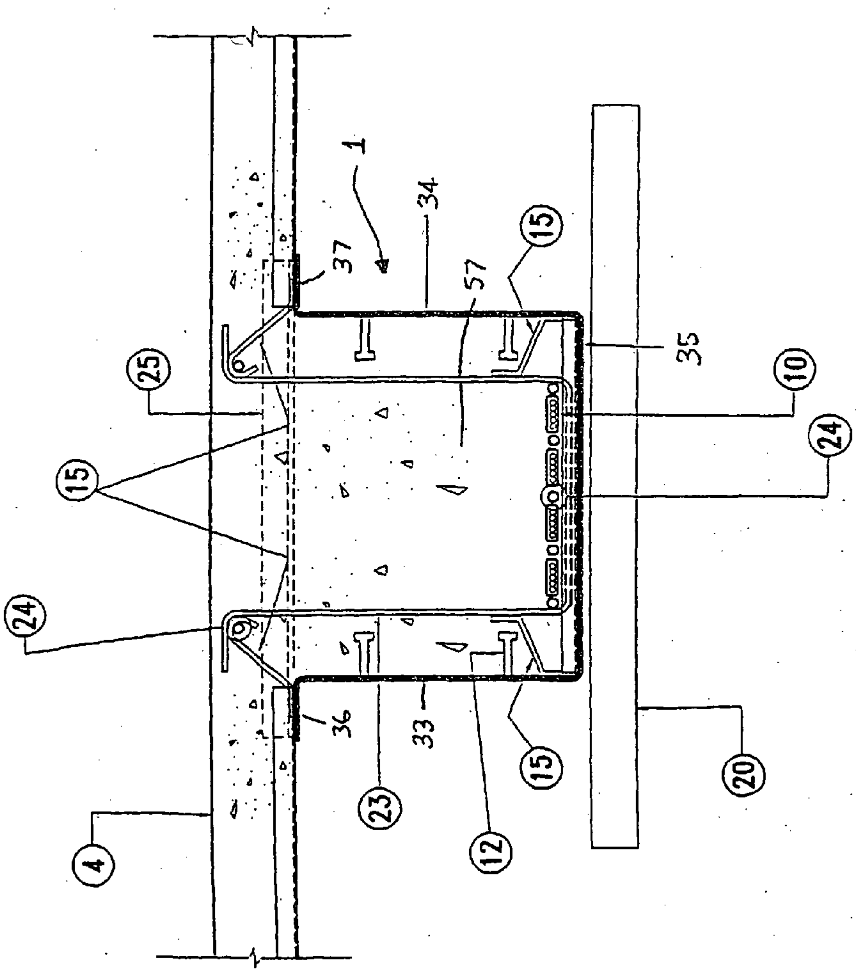


FIGURE 5

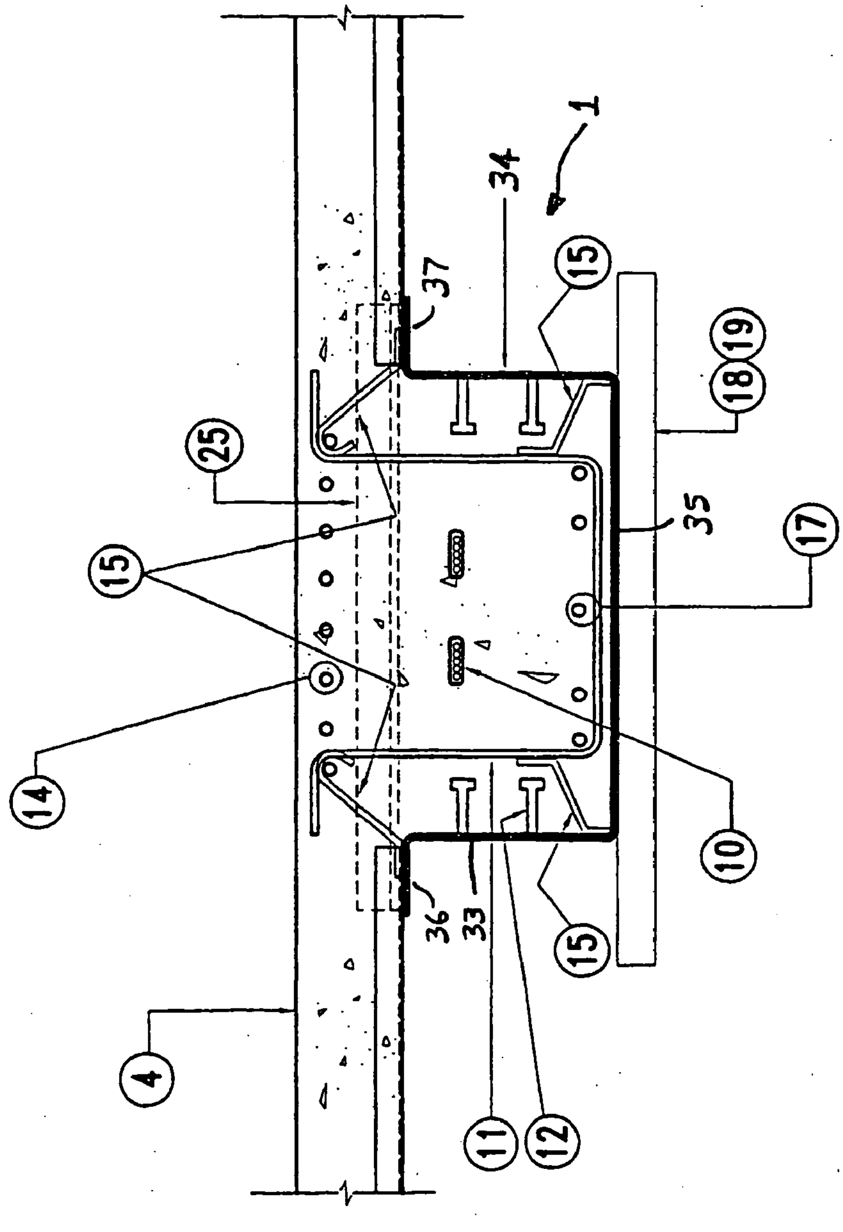


FIGURE 6

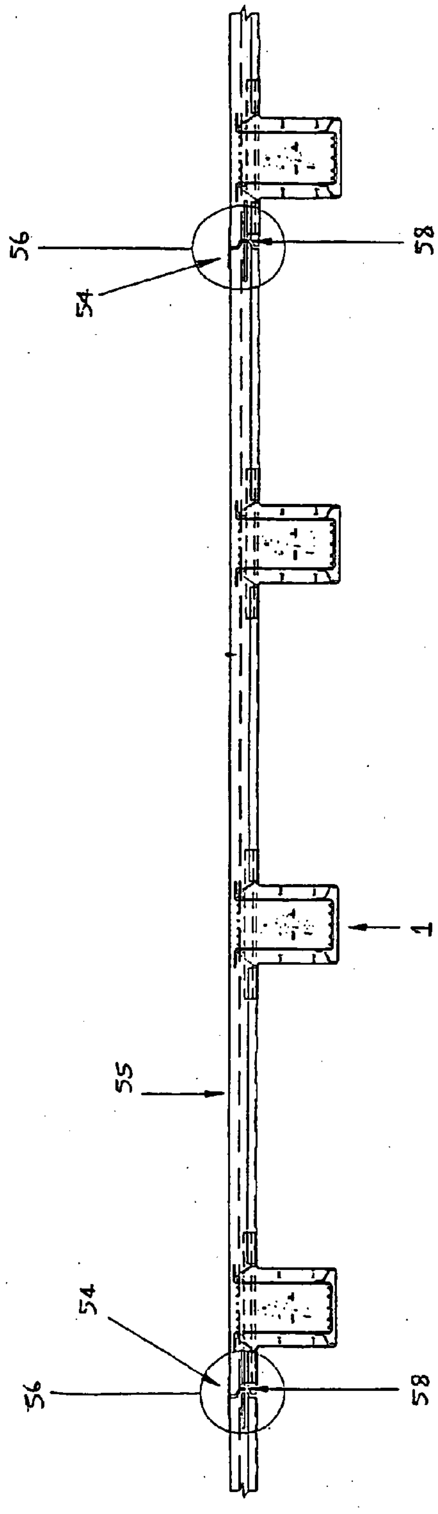


FIG. 7

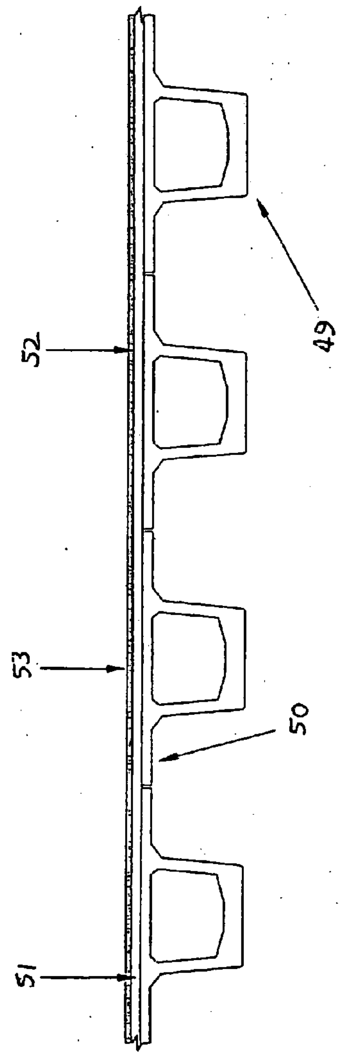
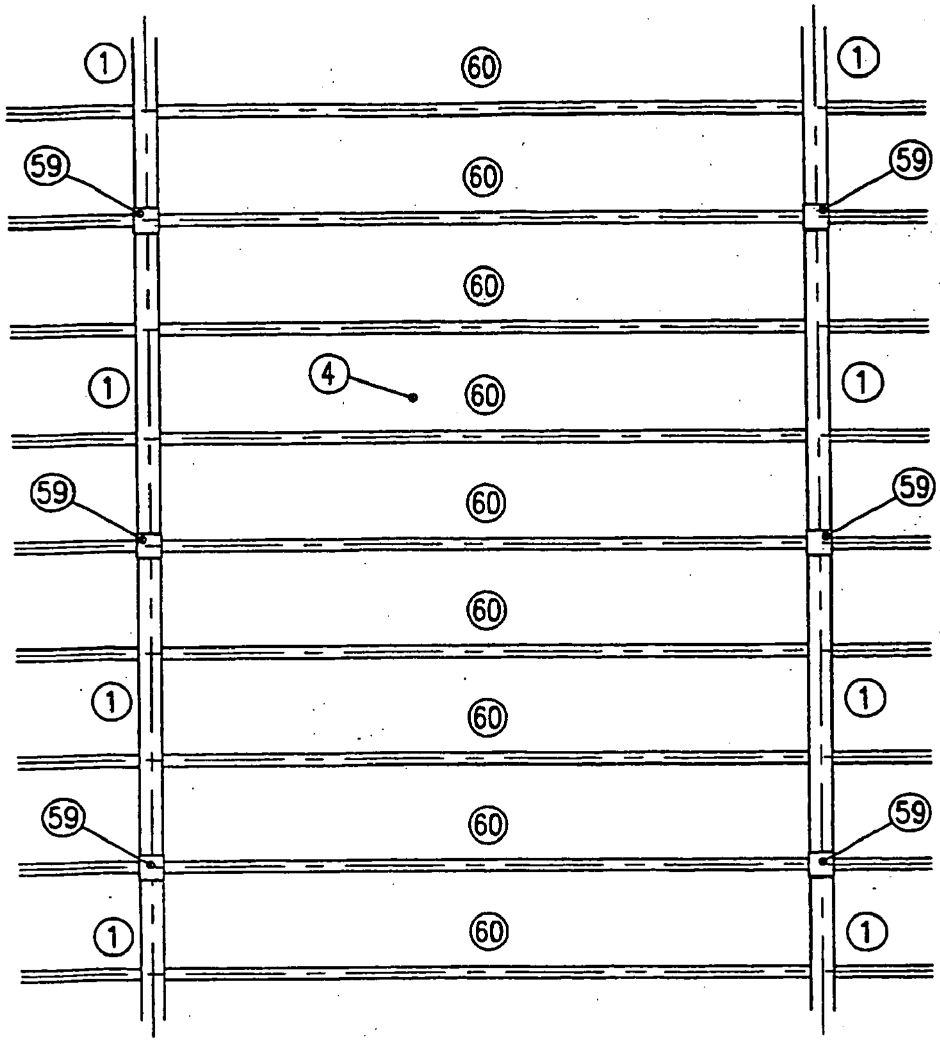


FIG. 8



PLAN

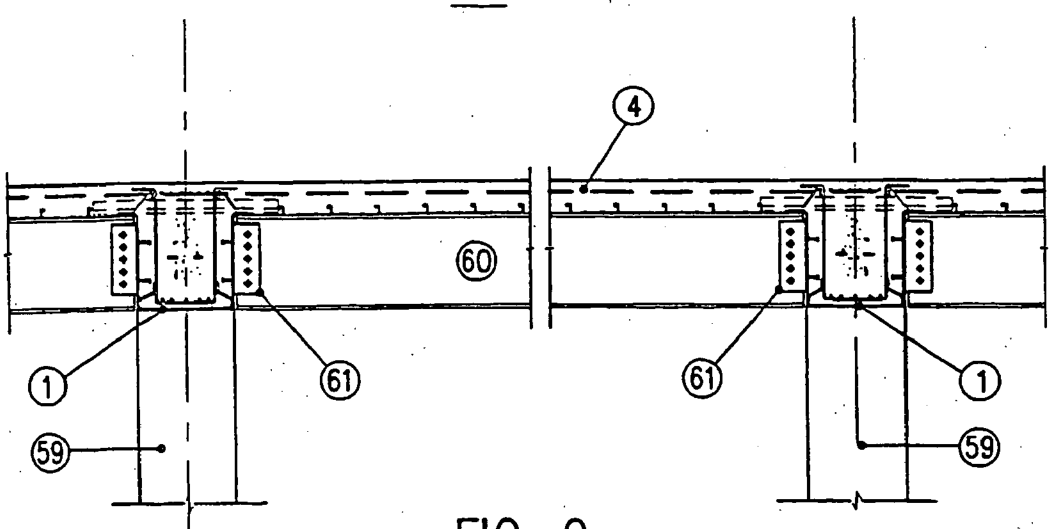


FIG. 9

BUILDING STRUCTURAL ELEMENT

FIELD OF THE INVENTION

[0001] This invention relates to a building structural element and a method of making a building structural element. More particularly this invention relates to a building structural element and method of making such an element which is used in floor systems of buildings.

[0002] The invention may also be used for many other building uses, such as a roof deck over road tunnels, railway tracks and the like. It can be used for large multi-bay floor spaces, particularly with high floor to floor dimension and/or long spans in one or both directions and/or high floor loadings such as floor decks for retail, recreational or other use. It can also be used for bridge decks and for any other uses where long spans and/or high loads have to be carried between supports.

[0003] One particular aspect of the invention relates to a floor beam used in the construction of floor systems of a building and is preferably made from a combination of two components, preferably made from steel, and a cementitious material such as concrete.

BACKGROUND OF THE INVENTION

[0004] Beams are generally required for floor systems of buildings that span in excess of 8 to 10 metres. This is typically the upper range or limit that floor slabs can extend without using beams for structural support. Supporting columns are usually located 6 to 9 metres apart of which a common spacing is 8.4 metres. This is a suitable office module that accommodates the widths of a column plus three spaces that may be used for vehicles located between adjacent columns and used for any parking levels below the office floors (or retail floors, institutional floors or other floors) of the building. Beams are required to span the larger dimension of a rectangular floor panel between a grid of four columns or between a pair of external columns on the outside of the building and the core or central part of a multi storey building. The core is typically used to house lift wells and other common rooms accessible by people on each floor. The floor systems spanning between these beams can and do take on many forms which depends on local availability, economies and the client's, engineer's or builder's preference or a combination of preferences of any one of these three entities.

[0005] Floor systems that span about 8 metres in one direction between the supporting beams can vary from formed concrete slabs on conventional formwork or large table forms, concrete slabs on metal tray forms that are temporarily propped on supports, secondary steel beams at close centres (2.1 to 3.0 metres) supporting a relatively thin slab on an unpropped metal tray forms. Also there are other proprietary systems such as various stressed plank systems that may be able to span a 7 to 8 metre distance unpropped.

[0006] For the supporting beams the upper range of suitability for reinforced concrete shallow band beams is about 10 to 12 metres. For pre-stressed shallow band beams (usually post-tensioned) the upper range of suitability is generally 12 to 14 metres. However for spans in excess of 12 to 14 metres, special attention and detail is required with common solutions being presented by either a steel floor beam system or a pre-stressed concrete floor beam system.

[0007] In the steel floor beam system there are a series of steel beams separated at their centres between 2.1 to 3.0 metres spanning the larger distance of the rectangular floor plan and are in turn supported by "primary" beams that span the shorter distance between the support columns. A particular problem that most engineers or designers are faced with in using a floor beam system is to reduce the amount of deflection of each beam either due to dead loads or live loads or a combination of both. Unnecessarily large deflections and vibrations of the floor systems can affect the amenity of the floor.

[0008] With the steel floor beam system used at present it has the disadvantage that each beam needs substantial connections at its supports. The beams and the connections usually require an applied protective coating to give them resistance to fire. Although such steel floor beams can be made to act compositely with the relatively thin floor slab that they support using shear studs, there is a small ongoing component of dead load deflection due to creep of the concrete and shear stud interface. Deflections of the steel beams due to dead loads mostly occur as soon as the loads are applied and can be allowed for by pre cambering the beam. However floor deflections and vibrations due to transient live loads are still an inherent problem particularly for larger spans, as the composite steel beam is less stiff than a reinforced concrete or pre-stressed concrete beam that would be used for the same span.

[0009] The other type of floor beam system that is generally used today is a post-tensioned, pre-stressed concrete floor beam system. They include concrete beams that have a deep aspect ratio, in other words the dimensions of the concrete beam are such that it is deeper than its width and these concrete beams are generally pre-stressed for spans in excess of 10 metres. The concrete beams are poured in situ with the slab that they support. Then pre-stressing is applied by post-tensioned tendons that are stressed when the concrete has attained sufficient strength usually within 3 to 6 days of pouring. The concrete beam and the adjacent slab panels are usually formed on large table forms that are crane lifted from floor to floor. Usually two sets of tables are used to maintain a preferred floor cycle of about one week with half the floor area poured at a time to provide continuity of work for the various trades. Very little prefabrication is possible other than the reinforcing cage for the beam that may or may not include the pre-stressing tendons. Any prefabricated cage needs to be well braced and cradled to be able to be crane lifted into the beam formwork. Generally no difficult connections exist at the supports of the beam as concrete stitches the beam to the supports. Where a poured concrete beam is supported at a concrete core that has been "jump formed" ahead of the main floors, the connection can be a simple rebate in the face of the wall of the core and reinforcing bars at the top and bottom of the beam are screwed into ferrules anchored into the core wall. Alternatively the beam can be seated into pockets left in the core wall.

[0010] The pre-stressed concrete floor system is stiffer than the steel floor beam system required to span the same distance and is thus less susceptible to floor vibrations and deflections due to transient loads. However as concrete creeps under sustained load, the incremental deflection of the floor system that occurs after the floor is occupied is not only that due to live load and light weight partitions, but also a significant proportion of deflection from the dead load due to the creep component. Pre-stressing may balance out most of the deflection due solely to the dead load. However, as the axial pre-stressing imparts a permanent axial force to the beam, there are losses of the prestress force from the resulting time-dependent shortening that will lead to further incremental deflection of the beam.

SUMMARY OF THE INVENTION

[0011] An object of the present invention is to provide a building structural element that substantially overcomes one or more of the above disadvantages. More particularly the present invention provides a building structural element having minimal deflections and substantially maintaining pre-stressed force axially therewithin and reduces the loss of such prestress force due to axial creep that shortens beams as in prior art systems.

[0012] According to a first aspect of the invention, there is provided a building structural element comprising:

[0013] a pair of beams, each beam in said pair having a first flange portion, a second flange portion and a web portion extending between said first flange portion and said second flange portion;

[0014] a plate member adapted to engage one of said first flange portion or said second flange portion of each beam such that an interior space is defined by each beam in said pair of beams and said plate member;

[0015] wherein cementitious material occupies a substantial volume of said interior space to form a non-unitary building structural element and said building structural element has residual or no deflection under dead load after application of a post-tensioned pre-stressing force.

[0016] The building structural element may further comprise one or more tendons extending along a length of the interior space defined between each beam and said plate member which may be a metal tray form soffit. Each one or more tendons may be pre-stressed to provide an upwardly directed force to counteract a portion of the dead load. The first flange portion of each beam may support part of a floor span after the element is secured at each end. Typically, the element may extend between a column and a core of a building. The element may end a short distance from the core and a short distance from the column or alternatively a short distance from a column at each end and is temporarily supported on false work at its end and possibly also at mid span.

[0017] Each beam is preferably constructed of a metal, such as steel, and the cementitious material is preferably concrete.

[0018] According to a second aspect of the invention, there is provided a building structural element comprising:

[0019] a pair of beams, each beam in said pair of beams having a top flange portion, a bottom flange portion and a web portion extending between said top flange portion and said bottom flange portion;

[0020] a plate member adapted to engage respective bottom flange portions of each beam in said pair of beams such that an interior space is defined by each beam in said pair of beams and said plate member;

[0021] wherein cementitious material occupies a substantial volume of said interior space to form a non-unitary building structural element and said building structural element has a residual or no deflection under dead load after application of a post-tensioned pre-stressing force.

[0022] The plate member may be a metal tray form soffit or other suitable horizontal soffit surface.

[0023] According to a third aspect of the invention, there is provided a building structural element comprising:

[0024] a generally U-shaped channel means having a pair of opposed side walls and a further portion joining each side wall;

[0025] wherein said pair of opposed side walls and said further portion define an interior space; and

[0026] wherein cementitious material occupies a substantial volume of said interior space and said building structural element has residual or no deflection under dead load after application of a post-tensioned pre-stressing force.

[0027] According to a fourth aspect of the invention, there is provided a method of making a building structural element comprising the steps of:

[0028] constructing a pair of beams, each beam in said pair of beams comprising a first flange portion, a second flange portion and a web portion extending between said first flange portion and said second flange portion;

[0029] forming and assembling a plate member such that the plate member engages one of either said first flange portion or said second flange portion of each beam so as to create an interior space defined by said pair of beams and plate member; and

[0030] pouring a cementitious material into said interior space to form a non-unitary building structural element such that on curing of said cementitious material and application of a post-tensioned pre-stressing force, said building structural element has substantially no deflection under dead load.

[0031] The pouring step may be done separately or as part of pouring the adjacent floor spans which the element supports. The element may have its ends initially supported on temporary support structures adjacent to the permanent end supports of the beam with possible additional support(s) along the span.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] A preferred embodiment of the invention will hereinafter be described, by way of example only, with reference to the drawings wherein:

[0033] **FIG. 1** is a plan view of part of a building floor system extending between a core wall of a building and an edge of the building;

[0034] **FIG. 2** separated into **FIGS. 2A and 2B**, is a side sectional view taken on the line A-A of **FIG. 1**;

[0035] **FIG. 3** is a sectional view of a structural element in use according to one embodiment of the invention taken on the line B-B of **FIG. 2**;

[0036] **FIG. 4** is a sectional view of the structural element in use taken on the line C-C of **FIG. 2**;

[0037] **FIG. 5** is a sectional view of a structural element in use according to a further embodiment and similar to **FIG. 3**;

[0038] FIGS. **5**(*a*) and **5**(*d*) are side views of the structural element in **FIG. 5** showing separate conditions of the structural element;

[0039] **FIG. 6** is a sectional view of the further embodiment of the structural element in use similar to **FIG. 4**;

[0040] **FIG. 7** is a side sectional view showing the structural element applied to a tunnel cover;

[0041] **FIG. 8** is a side view of a prior art pre-cast structural element; and

[0042] **FIG. 9** shows a plan view and a side view of structural elements across a floor span with secondary supporting beams.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0043] Shown in **FIG. 1** is a plan view of a pair of structural elements **1** that each extend from a perimeter column **2** on an outer edge of a building and the core wall **3** in the central part of the building. The span of each structural element may extend up to 18 metres in length and beyond and the separation between each element **1** is dependent on the separation between each perimeter column which as previously discussed may be equivalent to fit three spaces for cars in parking levels underneath the office floors which typically may be anywhere between 6 to 9 metres. Between the perimeter columns **2** extends an edge beam **16** and the floor **4** extends between the adjacent elements **1**. The edge beam **16** can incorporate an inner steel beam that stops just short of the sides of the perimeter columns **2**, so as not to require any physical connection to the column **2** and is supported on the same external support frame **19** that supports the main structural element **1**. This steel component of the edge beam **16** is precambered to take the dead loads, allowing minimal deflections along the edge of the building that may affect any facade glazing. It is to be noted that in **FIG. 1** although only two beams are shown any number of beams needed to support a designated floor area may be used.

[0044] With reference to **FIGS. 3 and 4** the element **1** is essentially constructed of an outer shell, typically made from steel which comprises first and second (side shell) beams **5** generally in the shape of I-beams each having a web portion **30** and at either end of the web portion **30** exists first and second flange portions **31** and **32**. Extending at the lower portion of the element **1** is a plate member or (form tray deck soffit) **13** generally made from metal and more particularly steel whereby this extends between each bottom or second flange portion **32** of the side shell beams **5** and is affixed or otherwise engaged with the flange portions **32**. Shear studs **12** extending from the web portion **30** of the side shell beams **5** are used to obtain integral action with the cementitious material that is poured into an interior space **57** of the shell defined by each beam **5** and the plate member **13**. Ligatures **23** generally in the form of a U-shape extend from within the floor **4** downwardly into the interior space **57** and through raised ribs of the plate member **13**. This is also used for extra support for the cementitious material that is poured into the interior of the shell. Furthermore reinforcement bars **24** are also provided within the element **1**. A closer or spacer **15** also is positioned within the floor **4** to tie the cage structure to the side shell beams **5**. Pre-stressed tendon elements **10** are several in number and shall be described with reference to **FIG. 2** hereinafter.

[0045] It is to be noted that the pair of beams **5**, and various reinforcing for the beam can be pre-fabricated off site in a controlled production line environment and be transported to the site with its reinforcement bars **24** and ligatures **23**, pre-stressed tendon elements **6**, **8** and **10** and bracing **15** to keep the reinforcing elements in place. Tendon element **6** is a dead end anchor for one of the tendons **10** and tendon element **8** is a pressed metal form incorporating a live end anchor recess. The two steel side shell beams **5**, coupled with bracing **25** for handling and transport, enable the complete assembly to be delivered to a site and in one simple lift, generally of around 4.5 tonnes for an 18 metre beam, be in place on pre-set support frames at its two ends, the support frames being designated by **18** and **19** and at its mid span with support frame **20**.

[0046] With reference to **FIG. 2** at the core wall **3** of the building the element **1** may be housed adjacent to a rebate **22** in the wall **3** and the individual reinforcement bars **14** and **17** screwed into ferrules **21** that have been precast into the jump form core wall **3** for both the top and bottom reinforcing connections to respectively go to reinforcement bars **14** and **17**. At the other end of the beam, connection to the external column **2** all that is required is that the connecting reinforcing bars **14** and **17** extend the required length past the face of the column **2**. These reinforcing bars **14** and **17** together with the beam ligatures **11** at the end sections of the element **1** are the only reinforcing steel for the element **1** that needs to be fixed on site.

[0047] Whilst small (up to 150 mm diameter) penetrations for fire sprinkler pipes, sewer pipes etc can be accommodated through the web of the element **1**, each end of each beam can be stepped up to accommodate any major service duct reticulation without impinging on the ceiling height by simply stepping up the bottom flange portion **32** of each steel side shell beam **5**. This is more clearly shown in **FIG. 2** where the step **7** is shown such that the space between the step and either the core wall **3** or column **2** designated as **9** provides a space for such a service duct reticulation if required. This step also allows the housing of the live or jacking end for one or more pre-stressed tendons **10**. The tendons **10** as mentioned are post-tensioned on site and may include any number as desired to be located in the interior space between each steel side shell beam **5**. Shown in **FIG. 2 a** pre-stressed tendon extends between the steps **7** in the bottom flange portion **32** and further pre-stressing tendons **10** are shown extending the full length of the beams and having a drape, in other words stressed in a concave manner and this is done to provide an uplift force or component that cancels out anywhere between 50% to 100% of the total dead load, although about 50-60% is usually sufficient for these beams, with the balance of the dead load and transient load capacity being provided by the steel shells of the prefabricated beam and the cementitious material. The dead load is deemed that weight comprised of the floor itself, the beams and permanent superimposed loads such as ceiling surfaces and floor finishes. The two steel side shell beams **5** are generally precambered so that once the temporary props are removed all of the deflection due to the dead load has been accommodated. In reality, the steel side shell beams **5**, the pre-stressing tendons and the concrete core filling the interior space of the pair of beams **5** interact together to share the total load. Nevertheless, the beams **5** and the pre-stressing tendons substantially prevent the reinforced component from taking any significant proportion of the load and certainly will not allow the concrete component to creep substantially as the pre-stressing tendons plus the precambered steel shell beams **5** between them are capable of taking the total dead load before the beam has deflected back to the horizontal.

[**0048**] In use, as mentioned, before the construction of the side shell beams **5**, shear studs and prestress tendons **10** and most of the beams reinforcement are done offsite and the reinforcing members **14**, **17** and ligatures **11** to the end section are done on site. The element **1** is then placed on its temporary supports just short of the rebate **22** in the core wall and the column at the other end. The reinforcing bars **14** and **17** are then placed into the respective ferrules and together with the ligatures **11** placed on site and thereafter the floor is poured such that the cementitious material, or generally concrete, is poured into the floor structure and allowed to fill a substantial volume of the interior space **57** within the side shell beams **5**. The combination of the two steel side shell beams **5** and the cementitious (concrete) material act integrally firstly by the concrete being poured between and over the steel beams and also via the shear studs **12** which are shop welded to the insides of each of the webs **30** of the beams **5**.

[**0049**] Thus the two side steel beams **5** significantly increase the axial steel content of the composite beam which acts as a compression member under the action of the pre-stressing load, such that loss of any prestress force due to axial creep shortening of the beam is minimal. This hybrid beam construction also then can have no overall deflection from dead load or it can be provided with a slight residual upwards camber before the transient loads. The remaining robust concrete beam as an uncracked section is available to assist the other two components with the incremental deflections due to the live load and any other transient loads.

[**0050**] As the external columns do not initially support any of the floor **4** and element **1**, the floor **4** and element **1** and columns **2** could be poured the same day. The columns **2** may be poured whilst the floor formwork and reinforcing to the floor panels **4** between the hybrid elements **1** is being installed. It is envisaged that with a well organised work force, even for large floor areas, three day floor cycles or even less could regularly be achieved by pouring half the floor on the first day, pouring the other half on the second day and preparing columns and lift perimeter shutters etc on the third day.

[**0051**] The concrete part of the element **1** is proportioned to take the reduced fire design load condition being 1.1 times the dead load plus 0.4 times the live load in Australia and similar figures used in other countries. Thus there is no need for either fire protection or a complicated fire engineering analysis if this can in fact provide a solution. The combined capacity of the steel and pre-stressed concrete beams is more than adequate to carry the in-service load which is generally 1.25 times the dead load plus 1.5 the live load in Australia and similar figures are used in other countries.

[**0052**] Most codes set deflection limits for incremental deflection, due to any creep component of the dead load plus the deflection due to live load and plus the weight of the partitions, at span/500. Thus for an 18 metre span this limit is 36 mm. For any building with large internal spans parallel to and adjacent to the side of the building, this magnitude of differential deflection between the floor next to a column at the side of the building, where there is zero deflection, and the mid span deflection at the adjacent internal beam, which may be as close as 2.5 metres for a steel beam floor system, is obviously too much. More stringent deflection criteria than the code requires may be necessary. The present invention through its hybrid steel and concrete beam can achieve maximum incremental deflections of the order of under 20 mm for such 18 meter spans.

[**0053**] With reference to **FIGS. 5 and 6** there is shown a further embodiment of the present invention wherein the structural element **1** is made from a single unitary or joined construction. Specifically, instead of having a pair of opposed beams linked by a plate member as in the first embodiment, the embodiment in these Figures has a generally U-shape channel formed of a pair of side walls **33** and **34** and a bottom or further portion **35** linking each of the side walls **33** and **34**. Preferably, the construction is made out of steel. Upper portions of the side walls **33** and **34** respectively have flange elements **36** and **37** for supporting part of the floor **4**.

[**0054**] With reference to FIGS. **5**(*a*), (*b*), (*c*) and (*d*) the structural element can be made from either a single piece of steel plate for example utilising four folds indicated in **FIG. 5**(*a*) at **38**, **39**, **40** and **41** (with no welding). Alternatively, the construction could be welded at point **42** and retain the four folds **38** through to **41** as shown in **FIG. 5**(*b*) giving a two plate construction. In **FIG. 5**(*c*) there is shown an alternative arrangement for the structural element retaining folds **38** and **41** but welded at points **43** and **44**, providing a three plate construction. Finally in **FIG. 5**(*d*) five pieces of steel plate could be used with no folds and four welds as indicated at points **45**, **46**, **47** and **48**.

[**0055**] The invention can also be used for shorter spans using shallower side shell steel beams with or without the use of pre-stressing tendons and with or without notches in the bottom of the ends of the beam to accommodate major service duct reticulation.

[**0056**] Where pre-stressing tendons are used for such shallow beams that do not have service duct step-ups that double as stressing anchor points then the anchors can be stressed from rebate pockets in the top of the floor that are filled in later after stressing and grouting of the tendons.

[**0057**] With reference to **FIG. 7**, and as mentioned previously, the invention is suitable for use in road tunnels using a "cut and cover" method. This involves lifting into position each of the structural elements, which already have their reinforcement and prefabricated in place, using relatively low load capacity cranes. This compares to extremely heavy precast pre-stressed concrete beams **49** used in prior art systems and shown in **FIG. 8**. The heavy precast pre-stressed concrete beams **49** have required extremely large cranes to be used for such lifting applications. With reference to **FIG. 8** the beams **49** have relatively thin flanges **50** and a topping slab **51** normally used for such applications. There is usually the necessity for tanking or using a waterproof membrane **52** over the full extent of the deck, which in turn requires a protective wearing slab **53**. All of these can be dispensed with by using a watertight integral pour that is possible with the use of the present invention. With reference back to **FIG. 7** this involves the use of fluid barrier means or more particularly water stops **58** and local tanking (or using waterproof membranes) **54** fitted to ensure that the roof of the tunnel is watertight. The floor deck **55** of the span between the structural elements **1** can be sufficiently thick and poured in sections of suitable size and, if necessary, pre-stressed between control joints **56**. The water stops **53** sand the local tanking or membranes **54** are fitted to each of the control joints **56**.

[**0058**] With reference to **FIG. 9** and as mentioned previously, the invention is also suitable for large multi-bay floor spaces, particularly with high floor to floor dimension and/or long spans in one or both directions and/or high floor loadings such as floor decks for retail, recreational or other use. The building element **(1)** can be used to span between columns **(59)**, to which secondary beams **(60)** are bolted **(61)**, supporting the floor slab **(4)** between the structural elements **(1)**.

[**0059**] The structural elements can be tailored to span the self-weight of the floor structure, plus construction live load during construction as simply supported between columns.

[**0060**] The structural element then forms a reinforcement concrete or pre-stressed concrete element that is continuous over several spans for the loads that need to be supported by the floor deck.

1. A building structural element comprising:

a pair of beams, each beam in said pair having a first flange portion, a second flange portion and a web portion extending between said first flange portion and said second flange portion;

a plate member adapted to engage one of said first flange portion or said second flange portion of each beam such that an interior space is defined by each beam in said pair of beams and said plate member; and

wherein cementitious material occupies a substantial volume of said interior space to form a non-unitary building structural element and said building structural element has residual or no deflection under dead load after application of a post-tensioned pre-stressing force.

2. An element according to claim 1 further comprising one or more tendons extending along a length of said interior space.

3. An element according to claim 2 wherein said one or more tendons may each be pre-stressed to provide an upwardly directed force to counteract a portion of said dead load.

4. An element according to any one of the previous claims that is used in supporting long-span floor areas within a building.

5. An element according to claim 4 wherein said first flange portion in each beam supports part of a floor span within said building.

6. An element according to claim 5 wherein one end of said element is secured to a column of said building and the other end of said element is secured to a core of said building.

7. An element according to claim 6 wherein prior to securing each end of said element, said element is temporarily supported on false work at said each end of said element.

8. An element according to any one of the previous claims having one or more shear studs extending into said interior space from either said web portion in each said beam so as to obtain integral action with said cementitious material.

9. An element according to any one of the previous claims wherein support means, in the form of ligatures, extend into said interior space to support said cementitious material.

10. An element according to any one of the previous claims further comprising a plurality of reinforcement bars extending along a portion of said element.

11. An element according to claim 10 wherein said other end of said element is housed adjacent a rebate in said core of said building.

12. An element according to claim 11 wherein individual ferrule means formed in said core are secured to individual reinforcement bars of said plurality of reinforcement bars.

13. An element according to any one of the previous claims wherein each end of said each beam is stepped to accommodate service ducts.

14. An element according to any one of the previous claims wherein each beam in said pair of beams is constructed of metal.

15. An element according to any one of the previous claims wherein said cementitious material is concrete.

16. A building structural element comprising:

a generally U-shaped channel means having a pair of opposed side walls and a further portion joining each side wall;

wherein said pair of opposed side walls and said further portion define an interior space; and

wherein cementitious material occupies a substantial volume of said interior space to form within the channel means a non-unitary building structural element and said building structural element has residual or no deflection under dead load after application of a post-tensioned pre-stressing force.

17. An element according to claim 16 having one or more shear studs extending into said interior space from either of said side walls so as to obtain an integral action with said cementitious material.

18. An element according to either claims 16 to 17 wherein support beams, in the form of ligatures, extend into said interior space to support said cementitious material.

19. An element according to any one of claims 16 to 18 further comprising one or more tendons extending along a length of said interior space.

20. An element according to claim 19 wherein said one or more tendons may each be pre-stressed to provide an upwardly directed force to counteract a portion of said dead load.

21. An element according to any one of claims 16 to 20 wherein each of said side walls has a flange element extending from a free end of each side wall, said flange element supporting part of a floor deck.

22. An element according to any one of claims 16 to 21 wherein each end of said element is secured to a support structure.

23. An element according to claim 22 wherein prior to securing each end of said element to said support structure, said element is temporarily supported on false work at said each end of said element.

24. An element according to any one of claims 16 to 23 further comprising a plurality of reinforcement bars extending along a portion of said element.

25. An element according to claim 24 wherein at least one of the ends of said element is housed adjacent a rebate in said support structure.

26. An element according to claim 25 wherein individual ferrule means formed in said support structure are secured to individual reinforcement bars of said plurality of reinforcement bars.

27. An element according to any one of claims 16 to 26 wherein each end of said each beam is stepped to accommodate service ducts.

28. An element according to any one of claims 16 to 27 wherein said channel is unitary in construction.

29. An element according to any one of claim 16 to **27** wherein said channel means is constituted by one or more joints joining adjacent portions.

30. An element according to any one of claims 16 to 29 wherein said channel means is constructed of metal.

31. An element according to any one of claims 16 to 30 wherein said cementitious material is concrete.

32. An element according to any one claims 16 to 31 wherein said floor deck has fluid barrier means to ensure said element is fluid tight.

33. An element according to claim 32 wherein said fluid barrier means includes a fluid stop and a fluid proof membrane.

34. A building structural element comprising:

a pair of beams, each beam in said pair of beams having a top flange portion, a bottom flange portion and a web portion extending between said top flange portion and said bottom flange portion;

a plate member adapted to engage respective bottom flange portions of each beam in said pair of beams such that an interior space is defined by each beam in said pair of beams and said plate member; and

wherein cementitious material occupies a substantial volume of said interior space to form a non-unitary building structural element and said building structural element has a residual or no deflection under dead load after application of a post-tensioned pre-stressing force.

35. A structural element according to claim 34 wherein said plate member is a soffit.

36. A structural element according to claim 35 wherein said soffit is a metal tray form soffit.

37. A method of making a building structural element comprising the steps of:

constructing a pair of beams, each beam in said pair of beams comprising a first flange portion, a second flange portion and a web portion extending between said first flange portion and said second flange portion;

forming and assembling a plate member such that the plate member engages one of either said first flange portion or said second flange portion of each beam so as to create an interior space defined by said pair of beams and said plate member; and

pouring a cementitious material into said interior space to form a non-unitary building structural element such that on curing of said cementitious material and application of a post-tensioned pre-stressing force, said building structural element has substantially no deflection under dead load.

38. A method according to claim 37 wherein said pouring step involves pouring said cementitious material as part of a floor deck and is poured into said interior space in the same pouring step as an adjacent floor deck.

39. A method according to claim 37 wherein said pouring step involves pouring said cementitious material in constructing a floor deck and said pouring is done separately to the pouring step in constructing said floor deck.

40. A method according to any one of claims 37 to 39 further comprising supporting the ends of said structural element initially on temporary support structures adjacent to a permanent end support of said structural element.

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